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IMPORTANT INTERFERENCES WITH NORMALS IN WEATHER RECORDS, ASSOCIATED WITH SUNSPOT FREQUENCY

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World Weather Records [1] comprise long tables of monthly weather records of pressure, temperature, and precipitation. At the bottom of each table are given normals of these elements, determined by averaging the long columns of monthly values for each month of the year. By subtracting these normal values from the numerous observed temperature values, tables of temperature departure are obtained. By dividing the numerous observed precipitation values by appropriate normal values, percentages of normal precipitation are tabulated.

By using percentages of normal precipitation thus obtained in a study of the effects of periodic solar variations on the precipitation of Peoria, Ill., important influences of sunspot frequency were uncovered. In the first place, the average percentage precipitation was about 9 percent higher when Wolf sunspot numbers exceeded 20 than when the Wolf numbers were below 20. In the second place, the average computed percentages showed large 12-month periodicities. The amplitude of these periodicities is about 8 percent when Wolf sunspot numbers exceed 20, and about 16 percent when the Wolf numbers are below 20.

The 12-month periodicities, just described, are roughly opposite in trends. With sunspot numbers above 20, as computed, high average percentage precipitation occurs in the first half of the year, low percentage precipitation in the second half. The maximum is in June, the minimum in October. With sunspot numbers below 20, low percentage precipitation occurs in the first half of the year, high percentage precipitation in the second half. The maximum is in August, the minimum in March.

[1] Smithsonian Misc. Coll., vol. 79, 1927; vol. 90, 1934; vol. 105, 1947.

To determine these facts I used the normal values of precipitation published in World Weather Records for most of the time, but for recent years, for which World Weather Records are not available, I

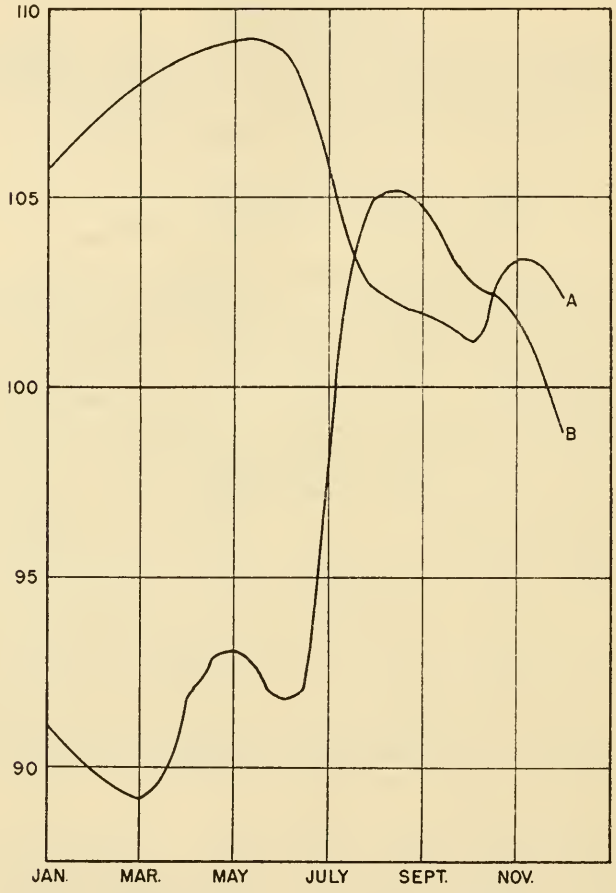

FIG. 1.—Twelve-month periodicities in precipitation at Peoria, Ill., depending on sunspot frequency, but hidden by using published normals.

used the normals published by the U. S. Weather Bureau, which differ slightly. These normal values for Peoria are as follows, in inches of precipitation.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Earlier...	1.75	1.70	2.80	3.28	3.94	3.71	3.75	3.44	4.24	2.44	2.32	1.66
Later....	1.79	1.95	2.76	3.15	3.70	3.66	3.76	3.10	3.79	2.92	2.31	2.04

The percentages of normal precipitation were computed for me by assistants, and I did not know until lately that two slightly different

sets of normals were used. In further studies I intend to compute two sets of normals for Peoria from 1856 to 1950. One set will be suited to sunspot numbers above 20, the other to sunspot numbers below 20.

Separating the 82 years of the Peoria tabular monthly mean values of precipitation, 1858 to 1939, into two groups, 50 years of high sunspots, 30 years of low sunspots, and 2 years being omitted as mixed, I computed the following monthly mean percentage precipitation values, based on the above quoted normals.[2]

	Jan.	Feb.	Mar.	Apr.	May	June
Wolf number > 20...	105.6	107.0	107.9	108.5	109.1	108.9
Wolf number < 20...	91.1	89.8	89.2	91.8	93.0	91.7
	July	Aug.	Sept.	Oct.	Nov.	Dec.
Wolf number > 20...	105.6	102.4	101.9	101.2	103.4	102.3
Wolf number < 20...	98.0	105.0	104.8	102.8	101.9	98.7

These results are plotted in figure 1. The curve A corresponds to Wolf numbers >20, the curve B to Wolf numbers <20. One readily sees that high Wolf numbers attend higher average precipitation at Peoria; that strongly marked 12-month periodicities are hidden by tables of percentage precipitation as ordinarily computed from published normals; and that the amplitudes of these periodicities are large, and their trends roughly opposite, for sunspot numbers above and below 20.

It is quite obvious that no sound results on periodic fluctuations of Peoria precipitation can result from tabulating percentage precipitation computed from published normals. Take, for instance, the 7-month solar-radiation periodicity. Tabulations of numerous 7-month columns, covering many years, would be used. One or more of these columns would start with June in years of low sunspot activity. Curve B of figure 1 shows that in this column there would be a spurious increase of 13 percent from June to August, and a spurious decrease of 6 percent from August to December. Another column would start perhaps with August in some other year. This column would contain a spurious decrease of 15 percent to its end in February.

If such sunspot influences are hidden in the published normals for one weather element at one station, it is probable that similarly caused defects are hidden in published normals for all weather elements at all stations. Statistical meteorologists will do well to be on the watch for them.

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[2] These computations employ the percentages of normals smoothed by 5-month running means.